the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Quantification of Wellbore Leakage Risk Using Non-Destructive Borehole Logging Techniques

Description

Through its core research and development program administered by the National Energy Technology Laboratory (NETL), the U.S. Department of Energy (DOE) emphasizes monitoring, verification, and accounting (MVA), as well as computer simulation, of possible carbon dioxide (CO_2) leakage at CO_2 sequestration sites, along with risk assessment of those sites. MVA efforts focus on the development and deployment of technologies that can provide an accurate accounting of stored CO_2, with a high level of confidence that the CO_2 will remain permanently sequestered. Effective application of these MVA technologies will ensure the safety of sequestration projects with respect to both human health and the environment, and provide the basis for establishing carbon credit trading markets for sequestered CO_2. Risk assessment research focuses on identifying and quantifying potential risks to humans and the environment associated with CO_2 sequestration, and helping to ensure that these risks remain low.

Schlumberger Carbon Services (SCS) along with other organizations have identified leaky wellbores as an important risk to storage integrity that warrants further study to develop methods to quantify the risk of leakage in active and abandoned wellbores. This three-year project — performed by SCS in partnership with Anadarko Petroleum Company, Princeton University, Rocky Mountain Oilfield Testing Center, and Los Alamos National Laboratory (LANL) — will develop methods for risk quantification that can be directly applied to individual wells using measurements from borehole logging tools. Models for leakage risk of wells can be developed that use these data to establish the overall probability of leakage of a given well. Methods to quantify the probability of leakage will be developed for specific zones in the well, e.g., the casing, cement, cement-casing interface, cement-formation interface, and any existing defects.

Primary Project Goal

The main goal for this project is to develop a new method to relate the risk of leakage of existing wells at sequestration sites to data collected by non-destructive cement mapping tools. The data will be taken from existing wells that have not been exposed to CO_2 in order to quantify the risk of leakage at the start of a project (prior to injection) and inform risk models. Supporting objectives include the following:

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COST

Total Project Value
$2,631,798

DOE/Non-DOE Share
$1,989,993 / $641,805

PARTNERS

Anadarko Petroleum Company
Princeton University
Rocky Mountain Oilfield Testing Center
Los Alamos National Laboratory

- Develop methods to establish the average flow parameters (porosity and permeability or mobility) from individual measurements of the material properties and defects in a well.
- Develop a correlation between field flow-property data and cement logs that can be used to establish the flow-properties of well materials and well features using cement mapping tools.
- Establish a method that uses the flow-property model (previous objective) to analyze the statistical uncertainties associated with individual well leakage that can provide a basis for uncertainty in risk calculations.

Accomplishments

This project was awarded on October 1, 2009. The project team will accomplish the above goal in three phases: (1) well log and flow parameter data collection and interpretation, (2) flow parameter correlation development and implementation, and (3) final result reporting and publication. Phase 1 will consist of collection and analysis of data and logs from existing wells that characterize the flow parameters of the wells (permeability, porosity, and flow pathways) and the condition of the casing, cement, cement-casing interface, cement-rock interface, and other defects. The Isolation Scanner will be used to image and map the casing, cement, and interfaces. Physical permeability and porosity data will be collected using point mobility tests, vertical isolation tests, and measurements on cores. A comprehensive well data set of this type is currently not available and is needed to accomplish all of the objectives of this project. Phase 2 will complete the project objectives through the development of mathematical relationships or models between the cement log data and the test and sample data to allow the estimation flow parameters based on the cement maps. The final stage, Phase 3, will be the publication and presentation of the results of the project. The publication will include the project data, the results of the correlations between the log and test data, an estimate of their uncertainty, and how the new relationships and uncertainties can be used to better quantify leakage risk.

Benefits

In anticipation of a large number of carbon sequestration sites starting in the next several years, it is important to understand the risk of CO_2 leakage through existing wells. This project will lead to a rigorous data set that can be used to understand well leakage probability and risk. In addition, this project may aid in the creation of a model using the data set to quantify leakage risk. Model validation and calibration resulting in quantitative risk of leakage will have a significant impact on both the quality and uncertainty in site performance and risk models. A reduction in uncertainty will allow for better decisions on the use of resources to repair wells and determine appropriate MVA technologies.

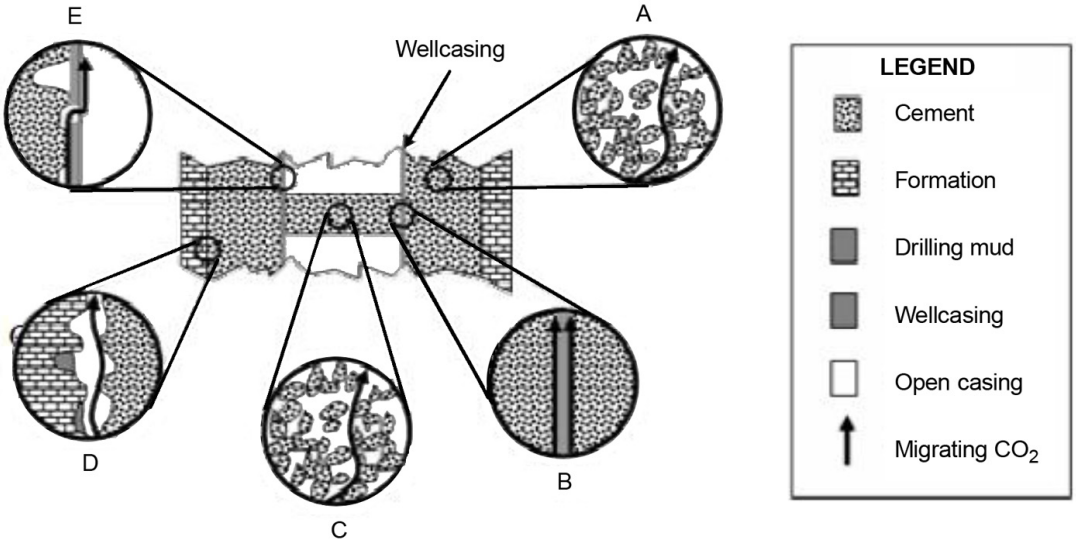

Figure 1: Potential CO_2 wellbore migration pathways: (a) through the pores or pathways of the well cement, (b) through annuli or defects that exist between the casing and the cement, (c) through the cement plug (for abandoned wells), (d) through an annulus or pathway at the interface between the cement and the formation, and (e) through a damaged casing and traveling up the inside of the well.

DE-FE0001040, March 2010